



Space X1 First Entry Sample

International Space Station: One mini-grab sample container (m-GSC) was returned aboard Space X1 because of the importance of quickly knowing first-entry conditions in this new commercial module. This sample was analyzed alongside samples of the portable clean room (PCR) used in the Space X complex at KSC. The recoveries of ^{13}C -acetone, fluorobenzene, and chlorobenzene from the GSCs averaged 130, 129, and 132 %, respectively.

Table 1. Analytical Summary of Space X1, First-Entry and PCR samples

| Module/ Sample | Date of Sample | NMVOCs ^a (mg/m ³) | Perfluoro (2- methyl) pentane (mg/m ³) | Freon 218 (mg/m ³) | T Value ^b (units) | Alcohols (mg/m ³) |
|--------------------|-------------------|---|--|-----------------------------------|---------------------------------|----------------------------------|
| Space X1 module | 10/9/12 | 33 | 10 | 2.4 | 0.69 | 10 |
| PCR | 10/7/12 | 1.3 | n/a | n/a | n/a | n/a |
| PCR | 10/7/12 | 2.2 | n/a | n/a | n/a | n/a |
| <i>Guideline</i> | | <25 | n/a | none | <1.0 | <5 |

^aNon-methane volatile organic hydrocarbons, excluding Freon 218

^bBased on 7-d SMACs and calculated excluding CO₂ and formaldehyde.

This result is quite consistent with the predicted T-value at first entry. Given that the module was sealed for 1.71 days before first entry, the predicted T-value was 0.62 T-units ($0.07 + 1.71 \times 0.32$), whereas the actual T-value was 0.69 T-units. Trimethylsilanol was the primary component contributing to the T-value.

Perfluoro (2-methyl) pentane is not an offgas product, but a heat-exchange fluid used by the Dragon vehicle. The amount of perfluoro(2-methyl) pentane predicted from the ground-based offgas test was much higher than we found in the first-entry sample because the leak of this fluid was stopped by repair of the thermal exchange system after the offgas test.

T-values were not calculated on the PCR samples because T-values are not applicable to ground-based samples. None the less, these samples show a relatively clean atmosphere in the PCR at the time of sampling.

John T. James, Ph.D.
Chief Toxicologist

Enclosures

Table 1: Analytical concentrations of compounds found in the Space X1 and PCR samples.
Table 2: T-values of the compounds found in the Space X1 sample.

TABLE 1
ANALYTICAL RESULTS OF
SPACEX-1 RETURN GRAB SAMPLE CONTAINER AIR SAMPLES

| CHEMICAL CONTAMINANT | CONCENTRATION (mg/m ³) | | |
|---------------------------------------|--|--|---|
| | AA05399 SIS 22525 Late Load PCR 10/7/12 @ 09:00 EDT | AA05400 SIS 34989 Late Load PCR 10/7/12 @ 11:00 EDT | AA05407 S/N 2013 Dragon Module Ingress 10/9/12 @ 17:40 GMT |
| | | | |
| | | | |
| TARGET COMPOUNDS (TO-14/POLAR) | | | |
| FREON12 | <0.025 | <0.025 | <0.050 |
| CHLOROMETHANE | <0.025 | <0.025 | <0.050 |
| FREON114 | <0.025 | <0.025 | <0.050 |
| METHANOL | 0.041 | 0.11 | 1.1 |
| ACETALDEHYDE | 0.028 | 0.10 | 0.25 |
| VINYLCHLORIDE | <0.025 | <0.025 | <0.050 |
| BROMOMETHANE | <0.025 | <0.025 | <0.050 |
| ETHANOL | 0.074 | 0.29 | 2.6 |
| CHLOROETHANE | <0.025 | <0.025 | <0.050 |
| ACETONITRILE | <0.025 | <0.025 | <0.050 |
| PROPENAL | <0.025 | <0.025 | <0.050 |
| ACETONE | 0.12 | 0.22 | 0.71 |
| PROPANAL | TRACE | 0.027 | 0.073 |
| ISOPROPANOL | 0.25 | 0.34 | 4.4 |
| FREON11 | <0.025 | <0.025 | <0.050 |
| FURAN | <0.025 | <0.025 | <0.050 |
| ACRYLONITRILE | <0.025 | <0.025 | <0.050 |
| PENTANE | <0.025 | TRACE | 0.079 |
| 2-METHYL-2-PROPANOL | <0.025 | <0.025 | TRACE |
| METHYLACETATE | <0.025 | <0.025 | <0.050 |
| 1,1-DICHLOROETHENE | <0.025 | <0.025 | <0.050 |
| DICHLOROMETHANE | <0.025 | <0.025 | <0.050 |
| 3-CHLOROPROPENE | <0.025 | <0.025 | <0.050 |
| FREON113 | <0.025 | <0.025 | <0.050 |
| N-PROPANOL | <0.025 | <0.025 | 0.076 |
| 1,1-DICHLOROETHANE | <0.025 | <0.025 | <0.050 |
| BUTANAL | <0.025 | TRACE | 0.058 |
| 2-BUTANONE | <0.025 | TRACE | 0.11 |
| CIS-1,2-DICHLOROETHENE | <0.025 | <0.025 | <0.050 |
| 2-METHYLFURAN | <0.025 | <0.025 | <0.050 |
| ETHYLACETATE | <0.025 | <0.025 | 0.074 |
| HEXANE | <0.025 | <0.025 | <0.050 |
| CHLOROFORM | <0.025 | <0.025 | <0.050 |
| 2-BUTENAL | <0.025 | <0.025 | <0.050 |
| 1,2-DICHLOROETHANE | <0.025 | <0.025 | <0.050 |
| 1,1,1-TRICHLOROETHANE | <0.025 | <0.025 | <0.050 |
| N-BUTANOL | TRACE | 0.096 | 1.5 |
| BENZENE | <0.025 | <0.025 | <0.050 |
| CARBONTETRACHLORIDE | <0.025 | <0.025 | <0.050 |
| 2-PENTANONE | <0.025 | <0.025 | <0.050 |
| 2-METHYLHEXANE | <0.025 | <0.025 | <0.050 |
| 2,3-DIMETHYL PENTANE | <0.025 | <0.025 | <0.050 |
| PENTANAL | <0.025 | TRACE | TRACE |
| 3-METHYLHEXANE | <0.025 | <0.025 | <0.050 |
| 1,2-DICHLOROPROPANE | <0.025 | <0.025 | <0.050 |

| | | | |
|---------------------------|--------|--------|--------|
| 1,4-DIOXANE | <0.025 | <0.025 | <0.050 |
| TRICHLOROETHENE | <0.025 | <0.025 | <0.050 |
| 2,5-DIMETHYLFURAN | <0.025 | <0.025 | <0.050 |
| N-HEPTANE | <0.025 | <0.025 | <0.050 |
| 4-METHYL2-PENTANONE | <0.025 | TRACE | 0.15 |
| CIS-1,3-DICHLOROPROPENE | <0.025 | <0.025 | <0.050 |
| 2-PENTENAL | <0.025 | <0.025 | <0.050 |
| TRANS-1,3-DICHLOROPROPENE | <0.025 | <0.025 | <0.050 |
| 1,1,2-TRICHLOROETHANE | <0.025 | <0.025 | <0.050 |
| TOLUENE | 0.32 | 0.28 | 0.49 |
| HEXANAL | <0.025 | TRACE | 0.094 |
| MESITYLOXIDE | <0.025 | <0.025 | <0.050 |
| 1,2-DIBROMOETHANE | <0.025 | <0.025 | <0.050 |
| BUTYLACETATE | <0.025 | TRACE | 0.25 |
| OCTANE | <0.025 | <0.025 | 0.057 |
| TETRACHLOROETHENE | <0.025 | <0.025 | <0.050 |
| CHLOROBENZENE | <0.025 | <0.025 | <0.050 |
| ETHYLBENZENE | <0.025 | TRACE | 0.27 |
| M/P-XYLENES | <0.025 | 0.035 | 0.35 |
| 2-HEPTANONE | <0.025 | <0.025 | <0.050 |
| CYCLOHEXANONE | <0.025 | <0.025 | <0.050 |
| HEPTANAL | <0.025 | <0.025 | <0.050 |
| STYRENE | <0.025 | <0.025 | <0.050 |
| 1,1,2,2-TETRACHLOROETHANE | <0.025 | <0.025 | <0.050 |
| O-XYLENE | <0.025 | TRACE | 0.19 |
| NONANE | <0.025 | <0.025 | 0.056 |
| 1,3,5-TRIMETHYLBENZENE | <0.025 | <0.025 | <0.050 |
| 1,2,4-TRIMETHYLBENZENE | <0.025 | <0.025 | <0.050 |
| 1,3-DICHLOROBENZENE | <0.025 | <0.025 | <0.050 |
| 1,4-DICHLOROBENZENE | <0.025 | <0.025 | <0.050 |
| 1,2-DICHLOROBENZENE | <0.025 | <0.025 | <0.050 |
| 1,2,4-TRICHLOROBENZENE | <0.025 | <0.025 | <0.050 |
| HEXAChLORO-1,3-BUTADIENE | <0.025 | <0.025 | <0.050 |

SPECIAL INTEREST COMPOUNDS***

| | | | |
|---------------------------------|--------|--------|--------|
| 1,3-BUTADIENE | <0.025 | <0.025 | <0.050 |
| ETHYLENE OXIDE | <0.025 | <0.025 | <0.050 |
| CARBON DISULFIDE | <0.025 | <0.025 | <0.050 |
| 2-METHYL-2-PROPENAL | <0.025 | <0.025 | TRACE |
| 3-BUTEN-2-ONE | <0.025 | <0.025 | <0.050 |
| 2-ETHOXYETHANOL | <0.025 | <0.025 | <0.050 |
| DIMETHYL DISULFIDE | <0.025 | <0.025 | <0.050 |
| OCTAFLUOROPROPANE** | <0.025 | <0.025 | 2.4 |
| PERFLUORO(2-METHYL)PENTANE) ** | <0.025 | <0.025 | 10 |
| TRIMETHYLSILANOL ** | TRACE | 0.11 | 1.4 |
| HEXAMETHYLCYCLOTRISSILOXANE & | 0.23 | 0.27 | 6.2 |
| OCTAMETHYLCYCLOTETRA-SILOXANE** | 0.031 | <0.025 | 0.11 |
| DECAMETHYLCYCLOPENTASILOXANE ** | 0.091 | 0.12 | 0.84 |

NON-TARGET COMPOUNDS***

| | | | |
|-----------------------------|--------|--------|--------|
| SULFURHEXAFLUORIDE | <0.025 | <0.025 | <0.050 |
| PROPANE | <0.025 | TRACE | TRACE |
| CARBONYL SULFIDE | <0.025 | <0.025 | TRACE |
| 2-METHYLBUTANE | TRACE | 0.054 | TRACE |
| 2-METHYL-1,3-BUTADIENE | 0.034 | 0.034 | TRACE |
| CYCLOPENTANE | <0.025 | <0.025 | <0.050 |
| 2-METHYL-PENTANE | <0.025 | TRACE | <0.050 |
| CYCLOHEXANE | <0.025 | 0.040 | TRACE |
| C4-SUBSTITUTED CYCLOPENTANE | <0.025 | <0.025 | <0.050 |

| | | | |
|---------------------------------|--------|--------|--------|
| C2-SUBSTITUTED CYCLOHEXANE | <0.025 | <0.025 | <0.050 |
| C9-ALKANE | <0.025 | <0.025 | <0.050 |
| C9-ALKANE | <0.025 | <0.025 | TRACE |
| ACETIC ACID, 2-METHYLBUTYLESTER | <0.025 | <0.025 | TRACE |
| UNIDENTIFIED SILOXANE COMPOUND | <0.025 | <0.025 | 0.14 |
| C10-ALKANE | <0.025 | <0.025 | 0.071 |
| 2-ETHYL-1-HEXANOL | <0.025 | <0.025 | 0.13 |
| C11-ALKANE | <0.025 | <0.025 | 0.088 |
| C4-SUBSTITUTED BENZENE | <0.025 | <0.025 | <0.050 |
| LIMONENE | <0.025 | <0.025 | <0.050 |
| C11-ALKANE | <0.025 | <0.025 | <0.050 |
| C11-ALKANE | <0.025 | <0.025 | <0.050 |
| C4-SUBSTITUTED BENZENE | <0.025 | <0.025 | <0.050 |

| | | | |
|-----------------------------|------|-----|----|
| TOTAL ALCOHOLS PLUS ACETONE | 0.50 | 1.0 | 10 |
|-----------------------------|------|-----|----|

| TARGET COMPOUNDS (GC) | | | |
|-----------------------|-------|-------|-------|
| CARBON MONOXIDE | <0.23 | <0.23 | TRACE |
| METHANE | ----- | ----- | <2.7 |
| HYDROGEN | ----- | ----- | 0.61 |
| CARBON DIOXIDE | ----- | ----- | 5200 |

| | | | |
|---|-----|-----|----|
| TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS) | 1.3 | 2.2 | 35 |
|---|-----|-----|----|

| | | | |
|---|-----|-----|----|
| TOTAL CONCENTRATION - OFP (NON-METHANE HYDROCARBONS) | 1.3 | 2.2 | 33 |
|---|-----|-----|----|

** Quantified using one-point calibration

*** Quantified using "B" response factor

& Quantified using response factor from internal study except as noted

< : Value is less than the laboratory report detection limit.

TRACE: Amount detected is sufficient for compound identification only.

OFP: Octafluoropropane

TABLE 2
ANALYTICAL RESULTS OF
SPACEX-1 RETURN GRAB SAMPLE CONTAINER AIR SAMPLES

| CHEMICAL CONTAMINANT | T-VALUE 7-day SMAC | T-VALUE 180-day SMAC |
|---------------------------------------|---|---|
| | AA05407 S/N 2013 Dragon Module Ingress 10/9/12 @ 17:40 GMT | AA05407 S/N 2013 Dragon Module Ingress 10/9/12 @ 17:40 GMT |
| TARGET COMPOUNDS (TO-14/POLAR) | | |
| FREON12 | ND | ND |
| CHLOROMETHANE | ND | ND |
| FREON114 | ND | ND |
| METHANOL | 0.01201 | 0.01201 |
| ACETALDEHYDE | 0.06371 | 0.06371 |
| VINYLCHLORIDE | ND | ND |
| BROMOMETHANE | ND | ND |
| ETHANOL | 0.00128 | 0.00128 |
| CHLOROETHANE | ND | ND |
| ACETONITRILE | ND | ND |
| PROPENAL | ND | ND |
| ACETONE | 0.01370 | 0.01370 |
| PROPANAL | 0.00663 | 0.00663 |
| ISOPROPANOL | 0.02947 | 0.02947 |
| FREON11 | ND | ND |
| FURAN | ND | ND |
| ACRYLONITRILE | ND | ND |
| PENTANE | 0.00044 | 0.00874 |
| 2-METHYL-2-PROPANOL | 0.00017 | 0.00021 |
| METHYLACETATE | ND | ND |
| 1,1-DICHLOROETHENE | ND | ND |
| DICHLOROMETHANE | ND | ND |
| 3-CHLOROPROPENE | ND | ND |
| FREON113 | ND | ND |
| N-PROPANOL | 0.00077 | 0.00077 |
| 1,1-DICHLOROETHANE | ND | ND |
| BUTANAL | 0.00444 | 0.00444 |
| 2-BUTANONE | 0.00355 | 0.00355 |
| CIS-1,2-DICHLOROETHENE | ND | ND |
| 2-METHYLFURAN | ND | ND |
| ETHYLACETATE | 0.00041 | 0.00041 |
| HEXANE | ND | ND |
| CHLOROFORM | ND | ND |
| 2-BUTENAL | ND | ND |
| 1,2-DICHLOROETHANE | ND | ND |

| | | |
|---------------------------|---------|---------|
| 1,1,1-TRICHLOROETHANE | ND | ND |
| N-BUTANOL | 0.01884 | 0.03767 |
| BENZENE | ND | ND |
| CARBONTETRACHLORIDE | ND | ND |
| 2-PENTANONE | ND | ND |
| 2-METHYLHEXANE | ND | ND |
| 2,3-DIMETHYLPENTANE | ND | ND |
| PENTANAL | 0.00156 | 0.00156 |
| 3-METHYLHEXANE | ND | ND |
| 1,2-DICHLOROPROPANE | ND | ND |
| 1,4-DIOXANE | ND | ND |
| TRICHLOROETHENE | ND | ND |
| 2,5-DIMETHYLFURAN | ND | ND |
| N-HEPTANE | ND | ND |
| 4-METHYL2-PENTANONE | 0.00105 | 0.00105 |
| CIS-1,3-DICHLOROPROPENE | ND | ND |
| 2-PENTENAL | ND | ND |
| TRANS-1,3-DICHLOROPROPENE | ND | ND |
| 1,1,2-TRICHLOROETHANE | ND | ND |
| TOLUENE | 0.03293 | 0.03293 |
| HEXANAL | 0.00520 | 0.00520 |
| MESITYLOXIDE | ND | ND |
| 1,2-DIBROMOETHANE | ND | ND |
| BUTYLACETATE | 0.00133 | 0.00133 |
| OCTANE | 0.00020 | 0.00409 |
| TETRACHLOROETHENE | ND | ND |
| CHLOROBENZENE | ND | ND |
| ETHYLBENZENE | 0.00206 | 0.00536 |
| M/P-XYLENES | 0.00486 | 0.00958 |
| 2-HEPTANONE | ND | ND |
| CYCLOHEXANONE | ND | ND |
| HEPTANAL | ND | ND |
| STYRENE | ND | ND |
| 1,1,2,2-TETRACHLOROETHANE | ND | ND |
| O-XYLENE | 0.00259 | 0.00512 |
| NONANE | 0.00017 | 0.00347 |
| 1,3,5-TRIMETHYLBENZENE | ND | ND |
| 1,2,4-TRIMETHYLBENZENE | ND | ND |
| 1,3-DICHLOROBENZENE | ND | ND |
| 1,4-DICHLOROBENZENE | ND | ND |
| 1,2-DICHLOROBENZENE | ND | ND |
| 1,2,4-TRICHLOROBENZENE | ND | ND |
| HEXACHLORO-1,3-BUTADIENE | ND | ND |

SPECIAL INTEREST COMPOUNDS

| | | |
|------------------|----|----|
| 1,3-BUTADIENE | ND | ND |
| ETHYLENE OXIDE | ND | ND |
| CARBON DISULFIDE | ND | ND |

| | | |
|------------------------------|---------|---------|
| 2-METHYL-2-PROPENAL | 0.01471 | 0.01471 |
| 3-BUTEN-2-ONE | ND | ND |
| 2-ETHOXYETHANOL | ND | ND |
| DIMETHYL DISULFIDE | ND | ND |
| OCTAFLUOROPROPANE | 0.00003 | 0.00003 |
| PERFLUORO(2-METHYLPENTANE) | 0.00007 | 0.00007 |
| TRIMETHYLSILANOL | 0.36179 | 0.36179 |
| HEXAMETHYLCYCLOTRISILOXANE | 0.06928 | 0.69277 |
| OCTAMETHYLCYCLOTETRAZILOXANE | 0.00040 | 0.00928 |
| DECAMETHYLCYCLOPENTASILOXANE | 0.00836 | 0.05573 |

NON-TARGET COMPOUNDS

| | | |
|---------------------------------|---------|---------|
| SULFURHEXAFLUORIDE | ND | ND |
| PROPANE | 0.00023 | 0.00455 |
| CARBONYL SULFIDE | 0.00208 | 0.00208 |
| 2-METHYLBUTANE | 0.00008 | 0.00008 |
| 2-METHYL-1,3-BUTADIENE | 0.00417 | 0.00833 |
| CYCLOPENTANE | ND | ND |
| 2-METHYLPENTANE | ND | ND |
| CYCLOHEXANE | 0.00012 | 0.00012 |
| C4-SUBSTITUTED CYCLOPENTANE | ND | ND |
| C2-SUBSTITUTED CYCLOHEXANE | ND | ND |
| C9-ALKANE | ND | ND |
| C9-ALKANE | 0.00008 | 0.00156 |
| ACETIC ACID, 2-METHYLBUTYLESTER | 0.00016 | 0.00016 |
| UNIDENTIFIED SILOXANE COMPOUND | 0.01405 | 0.14053 |
| C10-ALKANE | 0.00161 | 0.00161 |
| 2-ETHYL-1-HEXANOL | 0.00251 | 0.00251 |
| C11-ALKANE | 0.00184 | 0.00184 |
| C4-SUBSTITUTED BENZENE | ND | ND |
| LIMONENE | ND | ND |
| C11-ALKANE | ND | ND |
| C11-ALKANE | ND | ND |
| C4-SUBSTITUTED BENZENE | ND | ND |

TARGET COMPOUNDS (GC)

| | | |
|-----------------|---------|---------|
| CARBON MONOXIDE | 0.00204 | 0.00757 |
| METHANE | 0.00000 | 0.00000 |
| HYDROGEN | 0.00180 | 0.00180 |
| CARBON DIOXIDE | 0.40345 | 0.40345 |

| | | |
|---------------|---------|---------|
| TOTAL T-VALUE | 1.09622 | 1.96285 |
|---------------|---------|---------|

| | | |
|--|--|--|
| | | |
|--|--|--|

TOTAL T-VALUE - CO2

0.69277

1.55940

ND : Value is less than the laboratory report detection limit.

Note 1: Number of decimal places in T-Values do not represent significant figures of measurements.

Note 2: For compound concentrations reported as "Trace", the T-Value is calculated using one-half of the detection limit.